Bench, shell and casting procedure, in particular for engine cylinder heads

[0001] FIELD OF THE INVENTION

[0002] This invention generally regards aluminium casting technology and refers to the free-fall shell casting and low pressure moulding processes, which use specific shells and moulds mounted onto casting benches and low-pressure casting machines respectively for the two different technologies.

[0003] Typical examples of these technologies are those used, not exclusively, to cast engine cylinder heads.

[0004] BACKGROUND OF THE INVENTION

[0005] Generally, for medium and large-scale productions, all the aluminium casts of engine cylinder heads are produced with a free-fall technology shell or a low-pressure technology mould, as it is necessary to use inner cores to create the empty space inside the cast, and this cannot be achieved using any other technology. The cores are sometimes partially used on the outside to obtain undercut figures which cannot be obtained with metal parts.

[0006] Aluminium castings for engine cylinder heads created in a free-fall shell require casting benches on which to mount the shells. These benches are used to move the sides of the shell and the heads, and to expel the cast

from the shell using a plate fitted with extraction devices, the technique currently adopted by big foundries being to largely attribute the important technological functions to the shell itself. In the case of engine cylinder head casts made using the low-pressure casting method, big foundries use the technique of attributing the majority of technological functions to the mould for the same reasons as those adopted with the free-fall casting technique.

[0007] In this case, besides moving the mould, the low-pressure casting machine also uses a modern system to carry out the casting process from the lower part of the mould. As the lower part of the machine is occupied by the holding or maintenance furnace, the cast expulsion area is always in the upper part. This expulsion is carried out using a vertically sliding plate onto which extracting devices are mounted, which is rather awkward as it excludes the possibility of operating on the mould axis directly from vertically above, particularly affecting the core assembling device, which can only operate laterally, making it a very complicated device.

[0008] Upper expulsion is never applied when the upper part of the cast is obtained using sand cores, as the cast can only be lifted upwards if the upper part of the cast has been created using a steel male which can be gripped, as

the cores crumble leaving the cast in the shell. For this reason, in the case of free-fall casting technology, when there are sand cores in the upper part of the cast, as almost always happens with this technology, expulsion is never from the top but always from the bottom.

[0009] At the moment, in all foundries, the shells or moulds used are always specific, either for free-fall casting or low-pressure casting, as the two technologies are completely incompatible. The casting benches or machines for low-pressure casting are also completely different.

[0010] In the case of large-scale productions, instead of using a normal hand ladel for the casting of metal using the free-fall casting technique, the molten metal is introduced into the shell from above using a ladel operated by a casting robot, usually suspended from an overhanging beam, which is often also used for the automation of the core assembling device and the casting pick-up device.

[0011] The molten metal is taken by the robot from a nearby furnace and poured through a basin into vertical and horizontal casting channels in the shell until the figure and the open feeding risers are full.

[0012] The risers attract any sullage in the molten metal, which floats into them, and are used to top up the cast

as the cooled metal shrinks and to release the gases contained in the molten metal, as well any further gases which develop when the metal comes into contact with the cores, making the best possible casting in terms of mechanical characteristics, despite the odd disadvantage.

[0013] In the free-fall casting of engine heads, the shells and the casting benches are usually placed on the ground, in pairs or multiples of pairs, to facilitate the automation of the process. Alternatively, and only in the case of free-fall-casting and not low-pressure casting, the whole system can be mounted onto large, slow-moving turntables called "roundabouts" so that the casting point is maintained stable by the rotating movement. All the shells are filled by robots mounted on the respective benches.

[0014] In the low-pressure process, the mould comes into direct contact with the furnace, as the furnace, situated under the machine, is raised in order to make contact with the mould. The lid of the furnace is equipped with one or more vertical pipes which are immersed in the "bath" of molten metal. The top of these pipes comes into direct contact with the injection inlets applied to the bottom of the mould situated in the lower part. With the low-pressure introduction of dehydrated air between the surface of the molten metal and the lid of the furnace,

the pressure in the latter presses on the "bath" and forces the metal upwards into the mould through the immersed pipes and the injection inlets applied to the bottom of the mould until it is full. This latter process takes place without any feeding risers as their function is performed, where possible, by the pressure of the air exercised on the molten metal. The upper part of the mould is closed by a metal male which, besides determining the cast figure, prevents the metal forced upwards by the low pressure from coming out of the mould. The air pressure is maintained for a short time, until the molten metal begins to solidify, facilitated by coolers in the mould and, in particular, on the injection inlets, which contribute to the rapid solidification of the metal in the upper part of the inlet hole, preventing the molten metal injected into the mould from returning, due to the force of gravity, into the furnace when the air pressure is released and allowing the molten metal contained in the casting pipes to return into the "bath", avoiding its solidification. The solidified metal in the upper part of the injection inlet is then expelled together with the cast.

[0015] From that described above it is possible to easily deduce that, at the state of the art, to obtain a cast, it is first necessary to decide whether to use the free-

fall casting or low-pressure technique, as the two technologies are very different. In addition to the shell or the mould, the casting bench or low-pressure casting machine must be suited to the choice of free-fall or low-pressure casting. Once the decision has been made, the shell or mould must be made. The design and construction phases of this operation are very expensive, so a definite decision must be made before going ahead.

[0016] The decision to opt for one technique or the other is not always satisfactory, especially with regard to the low-pressure casting technique, as the decision, unless made in accordance with a specific request by the customer, is made on the basis of the founder's experience or depending on the equipment available at the foundry.

[0017] All existing casting technologies have their pros and cons. For example, an advantage of low-pressure casting is that the molten metal is transferred through immersed pipes to the bottom of the holding furnace, avoiding the inclusion in the metal of sullage and smelting residues that float at the top of the "bath". As the whole casting process takes place in a closed system and has no contact with the outside atmosphere, surface oxidisation is avoided. Should this occur, it would remain on the surface and would never enter the mould,

unlike that which occurs with free-fall casting. This technology involves taking the metal from a furnace near the shell and, despite all the precautions taken, small amounts of floating sullage could also be introduced into the shell. The majority of this sullage collects in the risers without causing excessive damage to the cast. It is harder to avoid taking surface oxidisation from the furnace, which is added to oxidisation created in the ladel and during the casting process itself, as everything takes place in contact with the outside atmosphere. Another negative aspect of free-fall casting is the turbulence which is generated in the metal during the casting process, which can cause slight damage to the cast.

[0018] The negative aspects that characterise free-fall casting in terms of quality are not serious, and are less important than those that characterise low-pressure casting which, due to the very fact that it is not possible to discharge any sullage into feeding risers, which are not present in this technology, along with the gases contained in the metal and those generated when these gases come into contact with the cores, together with other factors, cause a very high number of rejects due to porosity in the casts. In order to limit the consequent economic damage, many foundries have applied

an automated full silicone impregnation process to 100% of the production obtained with the low-pressure casting technology.

[0019] The fact that, despite the various negative factors, everything possible is done to use the low-pressure technique, depends largely on the fact that it allows considerable savings on running costs. This is due to the fact that less metal is required for each individual cast, as the feeding risers and vertical casting channels are eliminated. Consequently, the mechanical processes needed to separate the risers from the cast are also eliminated, as are the costs involved in recasting these and the vertical channels.

[0020] As mentioned earlier, as regards free-fall casting shells and low-pressure moulds, these are made as completely as possible, from a technological point of view, by the leading manufacturers of cylinder head casts. It is worth noting that the casting benches and low-pressure casting machines are always in operation and are part of the foundry's fleet of machinery. As such they are available in strictly limited supply, while shells and moulds are available in the quantities required for production and for the various different cylinder heads required, with consequent high costs for every shell or mould produced.

[0021] That described above highlights the need for strictness when opting for free-fall casting or low-pressure casting technology, without leaving room for the chance to intervene if the technology used is found to be unacceptable, but all this can be avoided by that indicated in the aims and advantages of the invention.

[0022] SUMMARY OF THE INVENTION

[0023] The main aim of this invention is to add a new type of casting technology to those that already exist. The new technology will be known as "combined" technology and will be capable of fully exploiting that obtainable by free-fall and low-pressure casting technologies.

[0024] Another aim of the invention is to present a new casting bench capable of holding both shells and moulds and of enabling the easy passage from one casting technique to the other. For this reason, the tool that determines the outer figure of the cast, currently called shell or mould depending on the technology used, will be referred to herein exclusively as "shell".

[0025] Another aim of the invention is that of enabling the operator to thoroughly clean the shell after extracting the cast and, where necessary, to quickly repaint the parts of the figure of the shell on the bench, with a very short production interval, which, being hot, facilitate the solidification of the paint, without

preheating the shell off the production line and so extending the production time.

[0026] Another aim of the invention is to present a single, standardised casting bench which enables the expulsion of the cast from the bottom of the shell, even when, in the case of low-pressure casting or "combined" technology, the holding or maintenance furnace is placed under the shell. This eliminates all cases of expulsion of the cast from the top of the shell, even when the latter is equipped with a metal feeding head or an upper male, freeing the vertical space above for more rational use by the core assembling robot and the cast extraction robot, without the need for complicated devices with a double vertical/horizontal movement.

[0027] Another aim of the invention is to present a support which can be applied to the top of all the shells, for all casting technologies, equipped with a vacuum chamber for connection to a vacuum system to remove fumes and gases from the shell during casting.

[0028] Another aim of the invention is to transfer some of the parts of the shell which do not form the casting figure, known as frames, from the shell to the casting bench, so that they are built just once with the bench and, being standardised, are not copied to provide the number of shells needed for production and for the

various kinds of casts and casting technologies.

[0029] Another aim of the invention is to present a casting bench equipped with a lower structure the height of which may be adapted to suit the casting process used. In particular, in the case of free-fall casting, where there is no furnace underneath the shell, the bench may be lowered for mounting on roundabouts. The same standard bench for use on roundabouts may also be placed directly on the ground when using the traditional free-fall casting system, but with smaller, lighter and cheaper shells.

[0030] Another aim of the invention is to enable the transformation of a shell for free-fall casting technology for use in low-pressure technology, constructing a metal upper male and related accessories, which will replace the core which usually forms the risers and the upper figure; consequently the shell will have no risers. It will be easy to revert to free-fall casting using "combined" technology, setting aside the upper male and reusing the core body.

[0031] Yet another aim of the invention is to provide a casting bench with split, overlapping side supports for core assembly reasons, on both side supports (right/left) or on just one side. The opening and closing movement of the two halves of the side supports will take place

independently by way of hydraulic cylinders or simultaneously (parallel movement), when split movement is not required. If there are no core assembly problems, the side supports will be supplied in a single unit.

[0032] A consequence of the invention is the elimination of the casting robot for free-fall casting shells, placed on the ground, when these are transformed for low-pressure casting or "combined" technology. The entry of the metal into the shell will take place from the underlying furnace and consequently the movement of the casting robot on the beam, usually positioned above the shell, will also be eliminated where the beam is already occupied by the core assembling device to assemble the cores in the shell and the cast pick-up device, facilitating the movement of the latter.

[0033] This invention presents a standardised conformation of the tools used for the production of a cast for engine cylinder heads or other compatible casts, with a single standard casting bench for the new shells presented here, or those which already exist and are modified for this purpose, for all the casting technologies referred to above, with inferior expulsion of the molten cast and with a tilting arm for moving all the parts of the shell situated in the upper part. The shells for the following technologies will be mounted on the standard bench:

[0034] - shells for low-pressure casting technology with metal upper male;

[0035] - shells for "combined" technology, or with low-pressure casting and free-fall feeding through risers created in the upper core;

[0036] - shells for "combined" technology with low-pressure casting and free-fall feeding through risers created in the metal feeding head;

[0037] - shells for traditional free-fall casting technology with upper casting basin and free-fall feeding through risers created in the upper core;

[0038] - shells for traditional free-fall casting technology with upper casting basin and free-fall feeding through risers created in the metal feeding head.

[0039] The casting procedure according to this invention envisages the concentration of all the tools in the same production space, with the use of a single casting bench for all casting technologies and with the same holding furnace, both for shells with low-pressure casting and shells with low-pressure casting but with free-fall feeding through risers, by means of use of the new casting technology, known as "combined" technology.

[0040] To simplify the shells, making them standard for all technologies, and to reduce their weight and cost, a consistent part of the frames has been transferred from

the shell to the bench, as specified further on.

[0041] Substantially, the shell is formed as follows: bottom, sides, fixed heads applied to the bottom, mobile heads, where fitted, which slide in the fixed heads, lower extractor plate and, depending on the technology used, male, feeding head or simply a vacuum plate and upper lid. The male and feeding head will also be mounted on a vacuum plate which will then be mounted on a support. The casting bench will be given side supports, the base plate, all the runners and sliding gibs. Consequently, the shells will be cheaper to make, will weigh much less and will be smaller, enabling savings during transportation over long distances, within the factory and during storage.

[0042] The casting bench and the shell will be managed by the same computer that currently manages the furnace and the low-pressure casting technology machine, so the bench will replace the machine, becoming standard for all technologies. The bench will be strong, properly cooled and insulated, so that it is not affected by thermal dilation. The shell will be free to dilate as necessary and to reach the right thermal balance with the addition of coolers governed by the computer. The operations for fastening the bottom, hooking the sides on the casting bench and fastening the extractor plate will take place

quickly by way of hydraulic cylinders (jacks).

[0043] The mobile heads, where fitted, will be moved by hydraulic cylinders and will be hooked up manually but quickly by way of a shot sleeve which blocks the mushroom of the head with that of the hydraulic cylinder.

[0044] With the same bench it will therefore be possible to obtain casts with free-fall feeding but casting of the molten metal from below, as in the case of low-pressure casting. This process will be called "combined" technology. In this case, to prevent the molten metal from overflowing through the risers, the shell will be fitted with a support with the plate covering the entire riser area to contain the thrust of the metal. This plate will also act as a vacuum plate, being mounted on the support with vacuum chamber. This support is applied and moved by a tilting arm hinged to the top of the bench.

[0045] The support will be connected to a vacuum device which will suck fumes and gases produced by the molten metal and from contact with the cores through the plate. For this purpose, the vacuum plate with the metal male or feeding head will be equipped with filters in line with the upper core risers or the figure to allow the evacuation of fumes and gases, blocking the passage of the molten metal. Therefore, the support and everything applied to it are an integrated part of the shell. In

particular:

[0046] - support with vacuum plate, which did not previously exist and is therefore part of the new design, for use in the new "combined" technology (low-pressure casting - free-fall feeding through risers), and to vacuum fumes and gases, to seal the upper surface of the shell and the cores that generate the feeding risers, to contrast and block the thrust of the metal against the cast feeding risers, preventing the molten metal from overflowing during the casting phase;

[0047] - support as above with vacuum plate and metal feeding head used in the new "combined" technology to seal the upper surface of the shell in line with the risers. The aforementioned feeding head acts as the male which generates the upper figure of the cast and, together with the sides, the risers that feed the cast using the free-fall technology;

[0048] - support and vacuum plate to which a metal male is applied, used in low-pressure casting technology to generate the upper figure of the cast without the risers.

[0049] The support with vacuum plate, the support with vacuum plate and feeding head and also the support with vacuum plate and upper male, applied to the three technologies, are all made with a plate to which filters are applied in line with the risers and the figure. These

filters converge in a fume and gas vacuum chamber, created in the support, which will be connected to a vacuum device. This vacuum is destined to improve the quality of the casts with all the technologies, including low-pressure casting technology, inasmuch as, with appropriate drainage holes on the sides of the male, it is possible to get close to the cores to vacuum fumes and gases, the majority of which currently remain inside the cast, generating widespread porosity.

[0050] The introduction of the new fume and gas vacuum system to all the technologies, including low-pressure casting, will contribute to improving the quality of casts and the working environment, regardless of the technology used.

[0051] The new shell used in the "combined" technology process will have no casting basin and no vertical casting channels, although the new project provides for their presence without moving on to the final phase. The cast will be extracted using a standard device inserted into the base plate of the bench and made up of a frame onto which the extractor plate with which all shells are equipped will be quickly fastened using hydraulic cylinders (jacks). In order to recuperate existing shells, the vertical casting channels in the lower part will be plugged.

[0052] Both new and existing shells will be fitted with injection inlets in the bottom, envisaging a fast cooling technique like that used in low-pressure technology to solidify the molten metal and avoid the return of the liquid metal into the furnace due to the force of gravity when the air pressure is cut off.

[0053] This new casting technique eliminates the disadvantages of free-fall casting deriving from taking sullage from the furnace and oxidisation, maintaining advantages such as discharging the same sullage and gases and fumes that develop during the casting process through the risers, which are now sucked out by the new devices illustrated.

[0054] With the application of the metal male envisaged in shells for low-pressure casting, which is replaced by a core or a metal feeding head in the free-fall casting procedure, all of which are managed by the same tilting arm on the bench, it is possible to easily transform a free-fall casting shell into a low-pressure casting shell by adding injection inlets in the bottom (lower part of the shell), and from lower-pressure to free-fall by removing the male and replacing it with a core.

[0055] The automation of a free-fall casting line of the current type envisages the use of a core assembling device a casting robot and a device for picking up the

cast. All movement often takes place on the same beam and three devices are hard to manage. With the elimination of the casting robot, the coordination of the movements is simplified, inasmuch as three are reduced to two, saving time and money. The furnace next to the shell is also eliminated, recovering production space.

[0056] The newly designed bench, to which various functions have been attributed, particularly the suitability for holding low-pressure casting shells and shells for free-fall casting, as well as those for use with "combined" technology, is also used for housing a part consisting of components that are normally part of the frames of the same shells. Consequently, these components will be made just once and will be an integrated part of the bench, thus avoiding the need to make new ones for every shell and for all the variants required for the various types of cylinder head casts or for other casts. In this way, the shells will cost and weigh less and be smaller.

[0057] From that described above, it should be obvious that the foundry will no longer have the problems described in the state of the art when choosing the casting technique best suited to the cast to be made, as it is easier to make changes if the choice made should turn out to be wrong, passing from one casting technology to the another by making slight alterations to the shells.

[0058] With the adoption of the newly designed benches, as with the newly designed shells, it is possible to make considerable savings on investments and save production space, and with the use of the "combined" low-pressure, free-fall feeding technology it is possible to obtain casts with impressive mechanical characteristics, reduction of rejects and improved production in terms of quality and quantity. The shell can be used for longer by simply repainting the figure parts.

[0059] As well as having a bench arm which can be tilted by over 90°, the supports of the shell sides can rotate upwards by over 45°, allowing the operator to easily repaint the shell figure and to clean it.

[0060] As mentioned earlier, the new bench, excluding the lower part of the structure, can be used on a "roundabout" or on the ground when it is necessary to use the traditional free-fall casting technology, as happens now. The frames of existing shells can easily be altered to standardise them and for use on the new bench. New shells will be made in accordance with the new project but will still have the traditional basin and vertical casting channels.

BRIEF DESCRIPTION OF THE DRAWINGS

[0061] Further details and characteristics of the invention will appear more clearly from the following description

of preferred embodiments thereof, with reference to the indicative non-limiting annexed drawings, wherein:

[0062] Fig. 1 shows a vertical section of a bench for a single-sided shell with the tilting arm raised and with a holding or maintenance furnace;

[0063] Fig. 1 shows a partial section of an enlarged part of the bench shown in Fig. 1;

[0064] Fig. 2 shows the bench seen from above;

[0065] Fig. 2 shows a vertical section of the bench seen from the side;

[0066] Fig. 3 shows a partial section of an enlarged part of the Fig. 3;

[0067] Fig. 4 shows the bench seen from below;

[0068] Fig. 5 shows a prospective view of the bench in the working position, with the tilting arm lowered, but without the shell;

[0069] Fig. 6 shows a vertical section of a bench seen from the front with the side supports inclined for cleaning and repainting of the shell figure parts;

[0070] Fig. 7 shows a vertical section of a bench similar to that shown in the previous Figures, but for a shell with overlapping double half sides;

[0071] Fig. 8 shows a section of the bench shown in Fig. 7 seen from the side and with the double half sides inclined;

[0072] Fig. 9 shows a prospective view of a casting bench similar to that shown in Figures 1-6, but with the supporting frame lowered for free-fall casting, in the working position but without the shell;

[0073] Fig. 10 shows a plan of a shell for "combined" technology with the sides open, for low-pressure casting but fed through free-fall risers created in the upper core;

[0074] Fig. 11 shows a cross-section of the open shell shown in Fig. 10 ;

[0075] Fig. 12 shows a longitudinal section of the closed shell;

[0076] Fig. 13 shows a prospective view of the closed shell;

[0077] Fig. 14 shows a cross-section of an open shell for "combined" technology with double sides and metal feeding head;

[0078] Fig. 15 shows a longitudinal section of the closed shell shown in Fig. 14;

[0079] Fig. 16 shows a prospective view of the same shell;

[0080] Fig. 17 shows a cross-section of an open shell with a metal upper male exclusively for low-pressure casting technology;

[0081] Fig. 18 shows a longitudinal section of the shell shown in Fig. 17 closed;

[0082] Fig. 19 shows an example of an existing shell for free-fall casting, altered for adaptation to the bench described in the invention, seen from above and with the sides open;

[0083] Fig. 20 shows a cross-section of the open shell shown in Fig. 19;

[0084] Fig. 21 shows a longitudinal section of the same shell closed; and

[0085] Fig. 22 shows a prospective view of the same shell closed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0086] With reference to the drawings, Figures 1-6 show a bench suitable for the quick assembly of single-sided shells and for a low-pressure casting process or for a new technology, called "combined", which envisages a low-pressure casting process fed using the free-fall technique through risers created in at least one core or in the upper part of the shell.

[0087] In order to better understand the structure of the new bench presented here, the main elements of a shell suitable for mounting on this bench are described below. Further details of the shell and its alternative versions will be described. With reference to Figures 10-18, a shell comprises at least one bottom 35, an extractor plate 38 fixed under the bottom, two sides 40, 40', front

42 and rear 42′ fixed heads applied to the bottom 35, front 44 and rear 44′ mobile heads, where fitted, which slide in the fixed heads. Inlets 36 for coupling to pipes protruding from a furnace containing molten metal and channels 36′ for delivering the metal into the shell are created in the bottom 35.

[0088] Returning to Figures 1-6, the casting bench mainly comprises a lower main structure 30, suitable for housing a holding or maintenance furnace 32, an upper main structure 31 resting on the lower structure, a base plate resting on the upper main structure 31, a cooled plate 16 positioned on the base plate 29 and on which the bottom 35 of the shell will rest, a frame 17 underneath the cooled plate 16 to which the shell extractor plate 38 will be hooked up, and two side supports 1 supported by rotating supports 2. The cooled plate 16 has a central opening 16′ into which the shell extractor plate 28 is fitted to hook onto the frame 17.

[0089] The furnace 32 is fed by molten metal from another melting furnace and is equipped with two pipes 32′ for the injection of the metal into the shells using the low-pressure and "combined" technologies.

[0090] At the top of the bench there is a hinged tilting arm 8 carrying a cylinder 10 to which overhead tools are fitted for vertical movement to and from the edge of the

shells, which will be described further on in this document.

[0091] For quick hooking of the shell extractor plate 38 to the bench frame 17, the latter is equipped with a slide 19, moved by a cylinder 21, destined to hook on to mushrooms 39 protruding from the extractor plate 38. Similarly, the side supports 1 are equipped with slides 24, moved by related cylinders 25, destined to hook on to mushrooms 41' on the sides 40, 40' of the shell for quick fastening to the side supports 1. The latter are activating by cylinders 4 and run along columns 5 and sliding gibs 20.

[0092] Fig.2 shows four cylinders 18 which, working in traction, move the frame 17 to which the cast extraction plate 8 is fixed, and four more cylinders 15 for the quick fastening of the bottom 35 of the shell to the cooled plate 16.

[0093] Figures 3 and 3a show cylinders 11 for moving the tilting arm 8 and reference locks 23 fitted to the side supports 1 for centring the sides 40, 40' of the shell.

[0094] In Fig.4 it is possible to see the lower cast expulsion device comprising the bench frame 17, which is suitable for accepting all types of extractor plates 38 for all the casting technologies, which are part of the shell.

[0095] Fig.5 shows the side supports 1 controlled by cylinders 4, sliding along the guide column 5 and sliding gibs 20 (Fig.1a), the rotating supports 2 for the side supports, with related pivots 2', the arm 8 and related pivot 28. In the front part of the bench there is a support for locking the arm 8 using a hydraulic cylinder 28' (jack) in the metal casting phase, for detaching the feeding head or upper male from the cast when removing the shell, or for simply raising the plate support.

[0096] Fig.6 shows the side supports 1 inclined for cleaning and repainting the shell figure parts, the related oscillating cylinders 7 fastened to the upper structure of the bench, and the joint between the upper 30 and lower 31 structures.

[0097] Figures 7 and 8 show a casting bench for use with low-pressure and "combined" technologies, like that described in the previous Figures, but suitable for accepting overlapping double half-sided shells, which are sometimes indispensable during the core assembling phase. Depending on requirements, these can also operate simultaneously, connecting them in a parallel position so that they become a single side. The half side can also be applied on just one side. The bench is fitted with lower 33 and upper 34 half side supports which slide along guide gibs 20 and columns 5. It is possible to see the

double cylinders 4 for moving the half sides.

[0098] The bench shown in Fig.9 differs from those illustrated previously in that it is a low-level structure, the lower part 30 of the same structure having been removed. The bench is only suitable for free-fall casting and can be mounted on a "roundabout" or positioned on the ground.

[0099] Figures 10-13 show a shell for the new "combined" technology for low-pressure casting fed using the free-fall technique through risers created in an upper core (not shown). There are inlets 36 and channels 36' for delivering the metal into the shell, skirtings 43 for quickly fastening the bottom 35 to the base of the bench, mushrooms 41' for quickly locking the sides 40, 40' to the side supports 1 of the bench. The shell also includes a support 46 for connection to the cylinder 10 carried by the tilting arm and to which a fume and gas vacuum plate 45 is fastened. The support 46 also contains a communicating vacuum chamber 46'' with a vacuum outlet 48. Number 44" is used to indicate the empty space that will be occupied by the cores after core assembly.

[00100] Fig.13 shows seats 46' for a pivot 28" for hooking on the tilting arm 8 of the bench (fig.1), the lock seats 23' for centring the sides 40, 40' in the side supports 1, and lock seats 14' for centring the bottom 35

on the base plate of the bench.

[00101] Figures 14-16 show a double-sided shell, suitable for the new "combined" technology consisting in pouring the metal at low pressure and feeding the cast using the free-fall technique through risers 51' created in a metal feeding head 51 fastened to the support 46 with a vacuum plate 45'. The shell is equipped with lower half sides 49, 50 which enable core assembling which would otherwise be impossible, and upper half sides 49', 50' which complete the composition. This shell can be mounted and moved exclusively from the double-sided bench shown in Figures 7 and 8.

[00102] In the case of low-pressure casting, the metal feeding head 51, to create the figure of the upper part of the cast, is replaced with a metal male 52, as shown in Figures 17 and 18. This too is fastened to a vacuum plate 45" and is equipped with vacuum holes or channels 52' at the bottom of which there is a filter to block the passage of molten metal.

[00103] Figures 19-22 show an example of an existing shell for free-fall casting which can be adapted for use with the new bench. The change consists in removing part of the frames from the shell, indicated with dotted lines, to standardise it in compliance with the new project, as these parts are already present on the new

bench. By adding the casting inlets 36 on the bottom 35 for delivering the metal at low-pressure and retaining the cast feeding risers, it is also possible to use the "combined" technology for existing shells. In particular, the parts eliminated are the base 55 with the related accessories and the supports 56 for the sides 57. To standardise the latter it is possible to add plates 58. The casting basin 53 can be retained, even if not used, by closing the related casting channels 54 and 54'.

[00104] In short, the innovative characteristics of the casting bench presented here are:

[00105] - single standard bench for shells with traditional free-fall casting technology and for shells with low-pressure casting technology, the only variant being the presence of a low-level structure for free-fall casting inasmuch as, for this technology, which does not provide for the use of the holding furnace, the lower part of its structure is removed;

[00106] - single bench as above, for casting from the lower part (bottom) for "combined" technology, for low-pressure casting shells with free-fall feeding of the cast through risers (use tall structure);

[00107] - single bench from which upper expulsion has been eliminated in the case of all technologies, transferring this to the lower part using a new expulsion

device inserted into the base plate. At the moment, upper expulsion is applied to all low-pressure casting machines. The elimination of upper expulsion makes core assembling and extraction of the cast easier by facilitating automation;

[00108] - single bench with expulsion of the cast obtained from below in the case of all casting technologies, including low-pressure casting, through a new device inserted in the base plate, even if it exists in the lower part of the holding furnace;

[00109] - single bench, with tilting arm to which a support with a feeding head plate or upper male or even just a plate for sealing the risers is applied, all of which are part of the shell. All the supports, plates, feeding heads and upper males are made specially to allow the vacuuming of fumes and gases. The tilting arm is also suitable for shells with two identical figures, and therefore with two feeding heads or two males and an enlarged sealing plate made to allow the vacuuming of fumes and gases from the cast;

[00110] - single bench with part of the frames normally attributed to the shells built-in to it, and therefore requiring construction just once. Valid for all technologies with savings on weight and shell construction costs;

[00111] - single bench for all casting technologies with side supports that tilt upwards by about 45° to clean the sides of the shell and repaint areas of the figure;

[00112] - single bench to which it is possible to fit split, overlapping side supports instead of single versions, onto which the half sides of the shell can be mounted quickly using a slide controlled by a cylinder fitted to each individual half side. Either one or both sides can be split. The side supports can also operate parallel with one another and revert to operation as a single side;

[00113] - single bench for mounting on a turntable or "roundabout", the only variant being the use of the low-level structure, as, for various operating reasons, only shells with traditional free-fall casting technology which do not necessitate the underlying furnace can be used on "roundabouts";

[00114] - single bench like that described in the previous paragraph for use on the ground, when it is necessary to use traditional free-fall casting technology with a casting robot, but with the newly designed shell or an existing shell with altered frames.

[00115] The innovations regarding the shell can be summarised as follows:

[00116] - shells for free-fall technology but with injection of the metal from below using the low-pressure casting technology, retaining the best aspects of free-fall casting technology with cast feeding risers, adopting the "combined" technology. These shells have no casting basin and no vertical casting channels, but are fitted with injection inlets in the bottom, like those used in low-pressure casting technology;

[00117] - shells like those described in the previous paragraph, for "combined" technology, to which a plate has been applied in the upper part, fastened to a support equipped with a vacuum chamber and an outlet for connection to a vacuum device for vacuuming fumes and gases. The support is moved by the tilting arm on the bench. The plate applied to the support is equipped with filters that converge in the support chamber and covers the whole area of the risers and the upper core to prevent the metal from overflowing. The plate is pressed onto the upper surface of the shell by the vertical hydraulic cylinder on the arm;

[00118] - shells like those described in the previous paragraphs, where the upper figure is obtained using a metal feeding head with cast feeding risers. The feeding head is applied for vacuuming fumes and gases to a plate which also seals the top of the risers;

[00119] - shells for low-pressure casting technology, where the upper part is obtained using a metal male which will be fastened to a plate equipped with filters and vents for vacuuming fumes and gases. The plate will vacuum gases and fumes from vertical discharges created on the sides of the male and from through holes in the same male, using a vacuum device applied to the support equipped with a vacuum chamber.

[00120] - newly designed and constructed shells for all casting technologies, from which part of the frames have been removed, attributing them to the bench, obtaining smaller shells which weigh and cost considerably less.

[00121] - existing shells for the current free-fall and low-pressure casting technologies, to be changed to eliminate parts of the frames already attributed to the new bench and with the construction of several accessories to standardise them in compliance with newly constructed shells, for use in free-fall, low-pressure and "combined" technologies;

[00122] - existing or new shells for all casting technologies, where the expulsion of the cast takes place from below using a new expulsion device fitted to the bench, onto which the shell extractor plate is fastened.

[00123] - existing or new shells equipped with "mushrooms" for mounting and quickly locking the

extractor plates, side or half sides onto the new bench;

[00124] - existing or new shells for free-fall casting, with reduced frames and weights, for mounting on new benches positioned on "roundabouts" or on the ground.

[00125] Description of an operating cycle for assembling a shell on the bench

[00126] 1) Place the complete shell on the base plate 29 of the bench, positioning the bottom 35 in the centring lock 14.

[00127] 2) Fasten the bottom to the base plate using with the quick fastening using the four hydraulic cylinders 15.

[00128] 3) Hook the mushroom 39 of the lower extractor plate to the frame 17 using the slide 19 and the hydraulic cylinder 21.

[00129] 4) Close the side supports 1 of the bench equipped with centring locks 23 on the shell sides and hook the sides (shell figure inserts) using the two slides 24 controlled by hydraulic cylinders 25.

[00130] 5) Hook the mobile heads 44 and 44' of the shell manually to the related hydraulic cylinders using the shot sleeves supplied with the bench.

[00131] 6) Close the tilting arm 8 on the bench and lock it in place with the hydraulic cylinder 28'. Hook the feeding head or male or the plate to the shell

support for fume and gas vacuuming, lowering the cylinder 10 and using the hooking pin 28'' of the bench to hook up the shell support.

[00132] 7) Connect any mobile males on the shell to the automatic system governed by the computer.

[00133] 8) Connect the Venturi pipes, where present and if required for use.

[00134] 9) Connect the coolers.

[00135] 10) Connect the vacuum device to the shell vacuum chamber support inlet, supported and moved by the arm on the bench for vacuuming fumes and gases.

[00136] 11) Test all the manual cycle movements, including the movement of the tilting arm and the extractor frame.

[00137] 12) Run empty automatic cycles after connecting the computer and selecting the programme to suit the casting technology to be used. Return to the manual cycle.

[00138] 13) Heat the shell if it has not already been preheated off the production line, ready for painting.

[00139] 14) Use the manual control to open and tilt the sides, rotating the arm to the open position.

[00140] 15) Paint the shell figures if this has not already been done off the production line: bottom, sides, any heads, any feeding head or upper male.

[00141] 16) Clean thoroughly, place the sides in the vertical position, carry out manual cycle test of all movements after heating and painting. Place everything in the open position with the extractor plates in the low position.

[00142] 17) Assemble all the cores and clean them.

[00143] 18) Close the mobile heads, sides, any males on the shell, tilting arm, hydraulic cylinder on the arm with support and anything else applied, to lock the top of the shell.

[00144] 19) Lift the holding or maintenance furnace into contact with the molten metal inlets used in low-pressure casting or "combined" technology.

[00145] 20) Check the temperature of the shell and the molten metal in the furnace.

[00146] 21) Switch on the automatic production cycle.

[00147] When using shells with four half sides or just two half sides on one side and a single side on the opposite side, remember that, for core assembling purposes, only the lower half sides must be closed at the start of the cycle. The automatic cycle must be suited to requirements.

[00148] Description of an automatic production cycle for a bench and a shell with two sides

[00149] 1) Start cycle with:

[00150] a-sides open in the vertical position

[00151] b-mobile heads open

[00152] c-expulsion plates in the low position

[00153] d-tilting arm open and all applications in the raised position

[00154] 2) Automatic core-assembly with core assembling device.

[00155] 3) Cleaning with a blast of air during the cycle to eliminate any grains of sand which become detached during core-assembly.

[00156] 4) Closure in sequence of heads, sides and any mobile males on the shell.

[00157] 5) Rotation of the arm in the operating position with the upper male or feeding head or closing plate with fume and gas vacuum applied, depending on the casting technology.

[00158] 6) Lowering by the hydraulic cylinder of the arm of the feeding head or the upper male or the closing plate with fume and gas vacuum, placing that applied to the arm in the operating position.

[00159] 7) Opening of the fume and gas vacuum system. Opening of the Venturi pipes, where fitted and if necessary.

[00160] 8) Casting depending on the shell mounted and according to the specific programme, for the specific

casting technology chosen.

[00161] 9) Opening of timed coolers.

[00162] 10) Timing of solidification.

[00163] 11) Closing of timed coolers.

[00164] 12) Raising of the feeding head or upper male to remove them from the cast, or of the sealing and fume and gas vacuum plate, if the upper part is created using a core.

[00165] 13) Rotation of the upper arm to the open position.

[00166] 14) Opening (extraction) of any mobile males on the shell.

[00167] 15) Opening and rotation of the sides upwards by about 45°.

[00168] 16) Opening of the mobile heads.

[00169] 17) Expulsion of the bottom with frame and expulsion plate.

[00170] 18) Positioning of cast pick up pliers.

[00171] 19) Hook up of cast.

[00172] 20) Removal of the cast from the shell.

[00173] 21) Lowering of the frame with expulsion plate.

[00174] 22) Cycle cleaning with shell open using air.

[00175] 23) Start new production cycle.